Exhibit L

Expert Report of David Weill, M.D.

In re W.R. Grace & Co., *et al.*

October 3, 2006

I. INTRODUCTION

A. David Weill, M.D. - Background Information

My name is David Weill, and I am the Medical Director of the Lung and Heart – Lung Transplant Program at Stanford University Medical Center. I am also an Associate Professor in the Division of Pulmonary and Critical Care Medicine at Stanford and am Board Certified in Pulmonary Medicine and a National Institute for Occupational Safety and Health (NIOSH) – certified B Reader, which is a demonstration of proficiency in the interpretation of pneumoconiosis – related chest radiographs. In addition to my own practice specializing in end-stage lung diseases, I have been a visiting professor at the National Institute for Occupational Medicine and Poison Control in Beijing, China. I have also had the opportunity to testify before the United States Senate Judiciary Committee and the Texas State Legislature regarding legislation addressing the handling of asbestos and silica claims. I am submitting this report in order to offer background on the proper diagnosis of asbestos-related lung diseases and a strategy for evaluating the outstanding claims against the W. R. Grace Corporation.

B. Goals of the Report

The purpose of this report will be several fold:

1.) To provide an overview of both malignant and non-malignant asbestos – related diseases

2.) To describe the appropriate way in which to diagnose the asbestos – related diseases

3.) To make comments regarding the methods used to diagnose occupational lung diseases in the litigation setting

4.) To devise and apply a diagnosing strategy to the outstanding Grace claims using appropriate medical criteria

5.) To review the medical and scientific literature regarding the worker and non-worker population in Libby, MT.

II. ASBESTOS-RELATED DISEASES AND CONDITIONS

Asbestos exposure has been associated with a variety of pulmonary manifestations, ranging from mild, asymptomatic findings primarily discovered radiographically to severe disease resulting in significant respiratory compromise and death. In this report, the clinical manifestations of all the asbestos-associated lung problems will be reviewed with particular emphasis on the non-malignant forms of the diseases. Some attention will also be given to the differences in occupational exposures and fiber types and their relative potential to cause disease. First, however, a brief review will be undertaken of the historical aspects of the asbestos-related pulmonary disorders.

A. History of the Medical Community's Understanding of Asbestos-Related Lung Diseases

Lung disease related to asbestos exposure is caused by inhalation of asbestos fibers and deposition of the fibers in the distal airways and alveoli of the lung. Although effective defense mechanisms exist in order to prevent fiber retention in the deep part of the lung, these defenses can be overwhelmed by large exposures. When a number of fibers sufficient to overwhelm the lung defense system is inhaled, a response in the lung is initiated that is characterized initially by inflammation and ultimately by fibrosis. It is likely that the malignancies associated with asbestos exposure share similar pathways as those that lead to fibrosis. As a result of these processes, asbestos exposure can cause nonmalignant conditions (such as asbestosis and pleural disease) and/or malignant

conditions (such as mesothelioma and lung cancer). I will discuss each of these conditions separately, although they may occur in association with one another. Clinical characteristics of the disease will be emphasized along with comments about causation.

Although the United States Occupational Safety and Health Administration has made regulatory efforts since the early 1970s to reduce asbestos exposure, between 1920 and 1970 the worldwide production of asbestos increased 25-fold. During this earlier period, it was recognized that asbestos exposure could lead to nonmalignant conditions such as asbestosis (a parenchymal fibrotic lung disease) and pleural changes (pleural effusion, pleural thickening, pleural plaques, and rounded atelectasis), as well as malignant conditions such as lung cancer and mesothelioma.

The first published report of asbestos being associated with disease was authored by William Cooke in the British Medical Journal in 1924 [1]. The manuscript described a patient who had worked in the Rochdale asbestos factory and developed a fibrotic lung disease. In subsequent reports, Thomas Oliver termed the lung condition "asbestosis". The first proposed link between lung cancer and asbestos exposure occurred in the 1930s and was first firmly established in a workplace-exposed population by Doll in 1955 [2]. Subsequent debate has continued to the present time and has centered on the relative roles of asbestos exposure and cigarette smoking on lung cancer development. While there is widespread agreement about the role of cigarette smoking in causing lung cancer, the relationship between asbestos exposure, asbestosis, and lung cancer continues to be intensely debated, both in the medical and legal arenas.

During the 1950s, researchers in South Africa discovered the link between asbestos exposure and mesothelioma in a crocidolite mining district in Griqualand West.

Papers published in the early 1960s more clearly defined this link in workers in the Cape asbestos mining areas [3-5]. More recently other causes of mesothelioma have been proposed [6-8], including most notably the simian virus 40 which contaminated the poliomyelitis vaccine between 1955 and 1963. Since that time, there has been medical literature both supporting and refuting a role for SV40 in mesothelioma causation [9, 10]. Furthermore, there may be as many as 20% or more of all mesotheliomas diagnosed in patients in whom a clear asbestos exposure history cannot be obtained [11].

B. Asbestosis

Asbestosis is a non-malignant, fibrotic parenchymal lung disease associated with significant asbestos exposure. The disease can be static or slowly progressive but, when progressive, can lead to profound respiratory disability. Once considered inevitable, progression of asbestosis is no longer certain, particularly when the patient is removed from exposure [12, 13]. The type of exposure is also an important factor in predicting influencing progression. Chrysotile exposure leads to progression in far fewer cases and at a slower rate than when asbestosis is due to amphibole exposure [14]. Gaensler and his colleagues also found that progression was more likely to occur when workers smoked cigarettes and when the latency period was short as compared to those who developed fibrosis within 20 years of the first exposure. Also, in patients in whom disease stability has been observed for greater than 10 years, the likelihood of progression is small. There is seldom progression when a patient presents with a low profusion chest radiograph (ILO category 1/0 or 1/1) and further exposure thereafter does not occur [15].

Mortality studies indicate that there is excess mortality in patients with profusion category 1 / 2 or above. The excess in mortality is due not only to asbestosis and

subsequent respiratory failure but also to excess lung cancer risk and mesothelioma [16]. Lower profusion categories (i.e. 1 / 1 or below) are not associated with excess mortality from any cause.

C. Benign Pleural Disease

Benign asbestos-associated pleural changes include parietal pleural plaques (focal pleural thickening), diffuse pleural thickening, and, rarely, benign asbestos effusions. Some would also include rounded atelectasis in this group, but it is not exclusively a disease of the pleura and therefore will not be discussed in detail. In any individual patient, one or a combination of the pleural findings may be present. While most cases of pleural disease are seen after asbestos exposure in the occupational setting, there can be pleural findings in individuals with lower levels of exposure, such as those found in environmental or non-occupational settings [17]. The precise mechanism by which pleural changes occur due to asbestos exposure has not been elucidated but likely involves the translocation of inhaled fibers to the pleura which then causes an inflammatory reaction on the parietal pleural surface. The inflammatory reaction then can lead to fibrosis or development of a pleural effusion.

1. Parietal Pleural Plaques

The association of pleural plaques with asbestos exposure was first described by Sparks in 1931 [18]. Pleural plaques are localized, discrete areas of dense fibrotic tissue located on the parietal pleural surface. Plaques can be either calcified or non-calcified and are generally found on the diaphragmatic pleural surface or along the lateral chest wall. More rarely, plaques can also be seen on the pericardium. When present along the lateral chest wall, the plaques form a sharp interface with the adjacent lung parenchyma

and are termed *in profile* plaques. Plaques may also exist on the anterior or posterior chest wall and in this position are described as *en face* plaques. The presence of pleural plaques is most closely correlated with duration since first exposure and is uncommon within the first 20 years of exposure [19].

Radiographic Appearance

Pleural plaques are seen radiographically as areas of discrete pleural thickening with or without calcification. Plaques are more easily detected when calcium is present, creating a dense, "white" appearance on the chest radiograph. The revised 2000 ILO classification for the pneumoconioses describes plaques as, by definition, not involving the costophrenic angle. Pleural plaques are most easily seen when in profile, where a sharp interface exists between the pleural plaques which are usually radiographically opaque and the lung parenchyma, which is radiolucent. The width of in profile plaques can vary significantly. The en face plaques, which are present on the anterior and posterior thoracic wall, instead present as an ill-defined hazy opacity overlying the lung parenchyma. Plaques either in profile or en face can calcify, which is a process that usually takes greater than 20 years [20].

It is generally accepted that the radiographic appearance of pleural plaques can mimic other conditions, either benign or more serious. Pleural plaques can be confused radiographically with shadows due to the serratus anterior muscle or due to excess subpleural fat in obese individuals [21]. Pleural fat pads typically start at the lung apex and extend down the lateral chest wall. Other diseases which can cause pleural calcification and be confused with pleural plaques due to asbestos exposure include tuberculosis, chronic empyema, and trauma to the chest wall, all of which are typically

unilateral. As in parenchymal lung diseases, CT scans are more sensitive in detecting pleural abnormalities [22-24]. However, due to cost and the potential harmful effects of radiation exposure, the generalized use of routine CT scanning is impractical and may be associated with adverse health effects.

Differential Diagnosis

In addition to being related to asbestos exposure, pleural plaques can be seen in tuberculosis, trauma, or following a hemothorax. Moreover, pleural plaques can be mimicked radiographically by pleural fat or fat outside of the chest cavity.

Functional Significance

The impact of asbestos-induced benign pleural conditions on pulmonary function has been controversial since this subject was first studied in the mid-1960s, but the most credible evidence indicates that the presence of pleural plaques is not associated with any adverse effects on pulmonary function. Epidemiologic studies investigating the potential association between pleural plaques and lung function abnormalities have been difficult to perform because of (1) the difficulty of taking into account asbestos exposure, which can cause parenchymal lung disease, such as asbestosis, which has effects on pulmonary function other than those mediated through pleural lesions, (2) the disagreement over the type and extent of radiographic pleural abnormalities (i.e. whether there are discrete pleural plaques or diffuse pleural thickening), and (3) the many potential confounding factors of reduced pulmonary function, such as excess body weight, cigarette smoking, age, concurrent occupational exposures, previous thoracic or abdominal surgeries, and prior chest diseases or trauma.

Based on the most reliable and scientifically accepted medical literature, the consensus is that most individuals with pleural plaques are asymptomatic and have no significant physiologic impairment [25-28]. Further, in the studies purporting to demonstrate functional impairment due to pleural abnormalities, a distinction was not made between those with localized pleural plaques alone and those with concomitant diffuse pleural fibrosis. In a study by Van Cleemput [26], the authors found no relationship in 51 patients with pleural plaques between the presence and the extent of the plaques and lung function nor was the size of the plaques related to cumulative asbestos exposure or time since first exposure.

In cases where pleural plaques are present and where patients are symptomatic and/or have abnormal pulmonary function tests, a scientifically sound study protocol should consider alternative explanations, such as concomitant emphysema in cigarette smokers or the presence of interstitial lung disease that is either asbestos or non-asbestos related. In a study by Schwartz and colleagues [29] for example, the presence of parietal pleural plaques was positively correlated with restrictive ventilatory defects, but the authors were unable to exclude the presence of concomitant parenchymal lung disease that was not detected by routine chest radiography. In another study by Sette and colleagues, the presence of parenchymal lung disease was predictive of gas exchange impairment, but the presence and number of pleural plaques did not provide an additional ability to predict gas exchange abnormalities above that attributable solely to parenchymal abnormalities [30]. Reaching a similar conclusion, Gaensler et al [31] found no functional impairment in workers with circumscribed plaques as compared to

those either with no exposure or those without plaques. Instead, functional abnormalities were observed only in those with plaques and asbestosis.

Additionally, Ohlson and colleagues [32] found no significant association between pleural plaques and lung function in a cross-sectional study of asbestos cement workers. When this group was followed longitudinally, no association between pleural plaques and reduced forced vital capacity (FVC) or forced expiratory volume in one second (FEV_1) was found over a 4 year follow-up, even after controlling for exposure. In other studies attempting to show a relationship between pleural plaques and reduced lung function [33], parenchymal fibrosis present in workers with pleural plaques was considered to be more important in the pathogenesis of restrictive lung changes. Considering the medical evidence with regards to the impact of pleural plaques on lung function, I can conclude that pleural plaques are not associated with respiratory impairment, in the absence of other concomitant lung disease.

Other studies regarding lung function and pleural plaques have reached different conclusions but have been significantly confounded. For example, 383 railroad workers exposed to asbestos were evaluated for the presence and extent of pleural plaques based on the ILO 1980 classification system [34]. Pleural plaques were observed in 22.6% of the workers. A decrease in the percent predicted of FVC was associated with the presence and the extent of the plaques, but a decrease in FEV_1 was not a consequence of the presence of pleural plaques. The diffusing capacity was similar in the groups with and without plaques. The findings were said to support an association between asbestos-related pleural plaques and decrement in lung function as measured by FVC. The FVC in the pleural plaque group versus the no plaque group was 86% predicted and 92.7%

predicted, respectively. However, as the authors note in their conclusion, "the clinical significance of the observed decrement is uncertain." Further, the study was limited by the presence of more smokers and older workers in the study group. Additionally, as the authors reveal in their discussion, a failure to exclude with certainty concomitant asbestos-associated interstitial fibrosis may have led to more restriction in the study population and, therefore, reductions in FVC. The confounding effect of co-existing pulmonary fibrosis likely led to reductions in FVC that were incorrectly attributed to pleural plaques and instead more likely were the result of concomitant pulmonary fibrosis.

Prognosis

There is insufficient medical evidence that establishes a causal relationship between pleural plaques and the development of mesothelioma. While there are no clearly defined mechanisms explaining how plaques could be a precursor lesion to mesothelioma, some studies have suggested a higher risk of mesothelioma among those with pleural plaques [35]. However, it remains unclear whether there is simply an association between pleural plaques and mesothelioma because both are associated with asbestos exposure, the presence of pleural plaques actually indicates sufficient exposure to increase the risk of mesothelioma development, or pleural plaques are precursor lesions in the development of mesothelioma. The studies to date do not provide the answer to these fundamental questions. It is apparent from the limitations of the literature purporting an association between pleural plaques and mesothelioma that the medical data are not sufficiently robust to demonstrate that a person with a pleural plaque

has a higher risk of developing mesothelioma compared to a person with a similar asbestos exposure but no pleural plaques.

The association between pleural plaques and lung cancer has also been debated in the medical literature, but the most reliable medical evidence indicates that pleural plaques are not associated with a higher risk of lung cancer. In the Hughes asbestos cement study, the presence of pleural plaques (in the absence of asbestosis) was not associated with an increased lung cancer risk [36]. The strength of this study was its prospective cohort design in which initial radiographic and exposure data were available in a large exposed population subsequently followed for cause-specific mortality. A subsequent meta-analysis performed by Weiss [37] indicated that, of the 13 studies analyzed, only 3 supported the hypothesis that lung cancer risk is elevated among persons with pleural plaques over the risk in unexposed people. The three positive studies were the most problematic from a methodological standpoint: 2 of the studies were from the same city in England and used similar data and 1 was a case-control study. One criticism of the analysis by Weiss, however, was that unrealistically large population studies would be needed to observe the statistical relation between pleural plaques and lung cancer and that low exposure studies were included in the analysis. Nonetheless, the medical evidence favored the conclusion that persons with asbestos-related pleural plaques do not have an increased risk of lung cancer in the absence of parenchymal asbestosis. A more recent Finnish study evaluated 16,696 male construction workers for cancer from 1990 to 2000 [38]. Standardized incidence ratios and relative risks were calculated in a multivariate analysis in comparison to a low-exposure group. Radiographic lung fibrosis (i.e. asbestosis) indicated a 2-fold and a high value of exposure index indicated a 3-fold

relative risk of lung cancer, but there was no elevated risk of lung cancer among those with pleural plaques.

Although there are some studies that show a positive correlation, very few have controlled for the presence of asbestosis. One such study from Sweden evaluated 1,596 men with pleural plaques [35]. The number of mesotheliomas and lung cancers was compared with the age- and year-specific expected incidence from the official cancer registry of Sweden. The risk of lung cancer for patients with bilateral pleural plaques without asbestosis was increased 1.4 times, which indicated a very small excess risk. Weaknesses of the Swedish studies have been discussed in a subsequent peer-reviewed publication [39] and included a potential bias toward patients who were being seen for strictly clinical (as opposed to research) reasons and the use of small chest radiographs that may have been unable to detect the presence of concomitant asbestosis.

Based on the evidence presented above, it is my opinion that the medical evidence does not support an association between pleural plaques and either mesothelioma or lung cancer.

2. Diffuse Pleural Thickening

Diagnosis of Diffuse Pleural Thickening

Thickening of the visceral pleura can be either unilateral or bilateral. If unilateral, the presence of pleural fibrosis from previous pneumonia with pleural reaction, empyema, or trauma must be excluded. Besides being asbestos-related, bilateral pleural thickening can be seen in collagen vascular diseases such as rheumatoid arthritis, scleroderma, or systemic lupus erythematosus. Up to one third of patients with diffuse

pleural thickening related to asbestos exposure had a previous benign asbestos-related pleural effusion or pleurisy [40].

Diffuse pleural thickening can be either seen on plain chest radiographs or, more easily, on CT scans [24]. According to the 2000 ILO classification system, diffuse pleural thickening by definition includes involvement of the costophrenic angle. If the costophrenic angle is not involved, pleural fibrosis is classified as localized (i.e. plaques).

Functional Significance

Most patients with diffuse pleural thickening are asymptomatic [19]. Some studies have demonstrated that those with diffuse pleural thickening can have a restrictive lung defect [40]. The degree of restriction depends on the extent of the diffuse pleural thickening. There is no scientifically reliable evidence that diffuse pleural thickening causes an obstructive defect. Restriction is a lung process that is characterized by a reduction in lung volumes, as opposed to obstruction which leads to hyperinflated lung volumes with decreased expiratory flow. Also, there is some evidence that a reduction in the diffusing capacity can occur in this group, likely as a consequence of reduced lung volumes [41]. When total lung capacity is decreased (as is seen in restriction), the DLCO, which depends on gas distribution throughout a certain lung volume, can be diminished purely as a result of having smaller lung volumes. The gas exchange function at the alveolar level, however, is unaffected by the diffuse pleural thickening. In order to account for reduced lung volumes, the DLCO can be corrected for lung volumes using the DLCO/VA, where VA means alveolar volume.

Prognosis

There is no credible medical evidence that patients with diffuse pleural thickening are at increased risk for the development of lung cancer or mesothelioma.

3. Benign Asbestos Pleural Effusion

An asbestos-related pleural effusion was first reported in the medical literature in 1964 [42]. Some but not all effusions cause pleuritic chest pain. The precise pathophysiology explaining the effusions is unclear but likely involves pleural inflammation from direct toxicity to mesothelial cells by asbestos fibers. Inhaled asbestos fibers can also indirectly cause pleural injury by the release of growth factors and inflammatory cytokines from the lung. Whatever the mechanism, most clinical information comes from small series which have provided only limited useful information.

Diagnosis of Benign Asbestos Pleural Effusions

Although identified many years ago, the medical evidence suggests that benign asbestos pleural effusions (BAPE) cause no functional impairment and do not have any adverse prognostic implications. Moreover, BAPE are transient and do not result in permanent pleural changes. In a study of benign asbestos pleural effusions [43], Epler defined BAPE as having the following characteristics: 1) related to asbestos exposure, 2) confirmed by chest radiograph or thoracentesis, 3) the exclusion of other diseases related to pleural effusion, and 4) no history of malignant tumors within the preceding three years. In his cohort, there were 34 benign effusions among 1,135 exposed workers compared with no otherwise unexplained effusions among 717 control subjects. Prevalence was dose-related with 7.0%, 3.7%, and 0.2% effusions with severe, indirect, and peripheral exposure, respectively. The latency period was shorter than for other

asbestos-related disorders with effusions being the most common asbestos-related abnormality during the first 20 years after exposure. Most effusions were small, 28.6% recurred, and 66% were asymptomatic. There was one mesothelioma six years after effusion.

In a study by Hillerdal and colleagues [44], 73 benign asbestos pleural effusions (occurring in 60 patients) were studied. The mean latency time from the first exposure to asbestos was 30 years, with a range of 1 to 58 years. The effusions lasted from 1 to 10 months, with a median of 3 months. The most common symptoms were pain, fever, cough, and/or dyspnea. A significant number of the episodes (46%) were asymptomatic. Fifty-three percent of the effusions were hemorrhagic, and 26% were eosinophilic. The authors concluded the following about benign asbestos pleural effusions: (1) a low occupational exposure can cause effusions, and (2) effusions related to asbestos exposure can occur many years after exposure to asbestos.

Robinson [45] reviewed 22 patients with benign asbestos pleural effusions who had a mean duration of exposure to asbestos of 5.5 years. The mean interval between exposure and presentation was 16.3 years. Five of the effusions were asymptomatic. The pleural fluid was usually hemorrhagic. The mean time to resolution of the effusion was 4.3 months. During a follow-up period of 28.1 years from initial exposure to asbestos (mean 22.8 years) and up to 17.2 years from initial presentation with a pleural effusion (mean 6.3 years), seven patients had a single recurrence and only one patient had multiple pleural effusions. Three patients experienced persistent pleural pain. It was not possible to predict the likelihood of recurrence of an effusion or the persistence of pleural pain

from the data at presentation. No patient subsequently developed mesothelioma or other neoplasm.

Therefore, based on these and other data, one can conclude that benign asbestos pleural effusions have no prognostic implications with respect to development of either malignant or non-malignant asbestos-related lung disease.

D. Mesothelioma

Mesothelioma can be either benign or malignant. The diffuse malignant form is a progressive disease, which can affect the pleura, peritoneum, pericardial, or tunica vaginalis. Malignant mesothelioma is rare, occurring in only 15 to 20 cases per million per year for men. The incidence in women is substantially less. The association of diffuse malignant mesothelioma with asbestos exposure was first established by Dr. Wagner in 1960, but there were case reports as far back as 1870 [46]. The exact mechanism by which asbestos inhalation leads to mesothelioma is unknown. However, not all diffuse malignant mesotheliomas are attributable to asbestos exposure. The incidence of primary (or idiopathic) mesothelioma varies in the medical literature, variously reported as occurring in 10% to 40% of all cases. Other postulated causes of mesothelioma have included radiation, trauma, and simian virus 40 (SV40), but none of these has been confirmed. The latency period for mesothelioma development is usually in the 20 to 40 year range. When mesothelioma develops over a shorter latency period, the exposure has usually been quite intense. Whether the incidence of mesothelioma is declining or increasing is a matter of some debate, but there is recent information that suggests that the peak incidence has already occurred and that the incidence of new cases is diminishing [47].

Epidemiology

Many epidemiologic studies have demonstrated an association between asbestos exposure and mesothelioma. The asbestos-mesothelioma association is particularly strong in occupations that involved heavy amphibole asbestos exposure, such as shipyard workers [48-51] and insulators [52-55].

After being initially described without specific regard to different fiber type exposures, more attention has been subsequently directed toward the contribution of amphibole exposures specifically to mesothelioma development. One of the earlier studies evaluating the impact on amphibole versus non-amphibole exposures was performed by McDonald and McDonald [56]. In their study, occupations of workers with mesothelioma were identified and matched with appropriate controls. High relative risks were found for people who worked with insulation, asbestos production and manufacturing, and heating trades other than insulation work. All of these occupations were characterized by heavy amphibole exposure. When compared to workers who had lower exposure predominantly to chrysotile, the findings in the McDonald study supported the greater mesothelioma producing potential of the amphiboles, as compared to chrysotile. The finding of a greater mesothelioma risk due to amphibole exposure has been supported by several subsequent studies [57-61].

To further define the mesothelioma risk in specific occupations without significant amphibole exposure, some occupations with low exposure to primarily chrysotile have been evaluated. Chrysotile asbestos has been used in many commercial products in the past. However, current usage is confined to four principal product categories: asbestos cement, friction materials, roof coatings and cements, and gaskets.

Current chrysotile products are different from the more friable chrysotile products previously used and discontinued some 20 years ago. In most situations today, chrysotile asbestos is encapsulated within a matrix which significantly diminishes fiber release. With modern control measures, exposures are therefore minimal. As an example, asbestos has been used in brake linings for many years, and there was concern over whether automobile mechanics that performed brake repair were at increased risk of developing asbestos associated disease. This concern persisted despite reports many decades ago that indicated that asbestos fiber release during brake maintenance was low [62]. Reports continued to suggest, however, that exposure to brake dust could be associated with an increased incidence of mesothelioma [63]. However, several studies that examined the issue recently more rigorously have indicated that the asbestos fiber release while performing brake repairs is very low and that exposure from this source is not associated with an increased risk of developing mesothelioma [64-68]. Another example of an occupational exposure that primarily involves chrysotile is gasket maintenance, which has been shown to be associated with low fiber release [69, 70].

The survival associated with diffuse malignant mesothelioma is poor. Most patients die within two years, either of respiratory failure or bronchopneumonia. Early results of treatment regimens using chemotherapy have been poor. Extrapleural pneumonectomy has been the traditional operative approach, but the results have been discouraging. More recent chemotherapy regimens have shown some promise, however. Response rates to chemotherapy have traditionally not exceeded 30%, but newer agents, for example antimetabolites such as pemetrexed, appear more promising. Response rates of up to 45% have been achieved when these agents are used in combination with

platinum compounds. A Phase III trial of pemetrexed with cisplatin is underway and may soon establish a standard of care. Raltitrexed combined with oxaliplatin has also been shown to be effective [71] as has gemcitabine when used as a single agent or in combination with cisplatin.

E. Lung Cancer

The link between lung cancer and asbestos exposure has been known for many years. From a clinical perspective, lung cancer in an asbestos exposed worker is similar to that found in non-exposed people. After the initial report in 1935 by Lynch and Smith of lung cancer in an asbestos worker, there was an additional follow-up case series in the 1940s [72]. First established epidemiologically in a workplace-exposed population by Doll in 1955 [2], debate has subsequently centered on the relative roles of asbestos exposure and cigarette smoking on lung cancer development. The Doll study was followed by the Selikoff paper [73] in 1968 which found an increased cancer risk in insulators who were smokers, as compared to non-asbestos exposed non-smokers. This finding led Selikoff to conclude that there was a multiplicative effect of asbestos exposure and cigarette smoke with regard to cancer risk.

While there is widespread agreement about the role of cigarette smoking in causing lung cancer, the relationship between asbestos exposure, asbestosis, and lung cancer has been intensely debated, both in the academic and legal arenas. The opinions regarding this relationship can be divided into three positions: one, exposure to asbestos of any amount increases the lung cancer risk; two, exposure to asbestos of amounts sufficient to cause asbestosis are necessary to attribute lung cancer to exposure; and, three, asbestosis (either radiographically evident or present on histologic material) is

necessary to attribute lung cancer to asbestos exposure in an individual case. The weight of the scientific evidence favors asbestosis as a necessary precursor in order to attribute lung cancer to asbestos exposure.

Pathogenesis

The role of asbestos in lung cancer development likely involves common biochemical pathways that lead to both fibrosis and carcinogenesis. While initially thought to be "scar carcinomas" (i.e. tumors that arise in a scarred area of lung due to transformation of the fibrotic tissue into cancerous tissue), lung cancers that occur in asbestotics likely do so as a result of molecular pathways that cause damage to DNA, leading either to fibrosis or to cancer development. Of course, whether an individual patient develops fibrosis or cancer or both likely depends on the nature and the extent of the cellular damage. In a clinical study involving the risk of lung cancer in those with cryptogenic (idiopathic) fibrosing alveolitis, Turner-Warwick and colleagues [74] found a risk ratio of 14.2 in male smokers with lung fibrosis not related to a specific cause. This study demonstrated that lung fibrosis, from any cause or without known cause, may be a marker for those with excess cancer risk. Similar studies have shown an excess cancer risk in patients with another fibrosing lung disease (scleroderma) [75, 76]. These studies indicated that there is a lung cancer risk that is not accounted for by age and smoking history.

Other pieces of clinical data supporting the lung fibrosis-lung cancer model include the fact that, while asbestosis leads to predominantly lower lung zone fibrosis, lung cancers associated with asbestosis can be in any lung zone and do not seem to have a predilection for any particular lung zone [77, 78]. Further, while most "scar

carcinomas" are adenocarcinoma cell type, the lung cancers associated with asbestosis can be of essentially any cell type [79] and are indistinguishable from cancers attributable to cigarette smoking [78, 80].

Epidemiology

The question of whether asbestosis needs to be present in order to attribute lung cancer to asbestos exposure continues to be debated, and several studies have been performed to evaluate the asbestos-lung cancer relationship. Despite this, there is disagreement about some fundamental aspects of the asbestos exposure-lung cancer risk. The link between asbestosis and lung cancer has been studied since the 1950s. Proponents of the assertion that asbestosis is necessary point to the original Doll study in 1955 that found that all of the 11 asbestos workers who died of lung cancer also had histological evidence of asbestosis. Further studies of the Quebec miners found that radiographic abnormalities consistent with asbestosis were found in most but not all the excess deaths due to lung cancer [81]. In the Quebec study, however, the chest radiographs used were often taken many years before death, and, therefore, there may not have been an adequate time period in order for fibrosis to become radiographically apparent.

In a necropsy study of 339 amphibole asbestos miners by Sluis-Cremer [82], the presence of asbestosis was significantly associated with the presence of lung cancer. Of the 35 cases of lung cancer, 24 were associated with asbestosis. Eleven cases of bronchial cancer occurred in men without asbestosis; all were smokers. Standardized proportional mortality rates indicated no excess of lung cancer in 302 exposed men without asbestosis. From these data, the authors concluded that in the absence of

histologically proven asbestosis, lung cancer in those exposed to asbestos was unlikely to be attributable to asbestos exposure.

In a study which had detailed radiographic information about an exposed cohort, Hughes performed a prospective mortality study of 839 men employed in the manufacture of asbestos cement products and examined the lung cancer risk in relation to lung fibrosis seen on chest radiographs and controlled for age, smoking, and exposure to asbestos [36]. In a follow-up period that extended more than 20 years after first hire, no excess of lung cancer was found among workers without radiographically detectable lung fibrosis, even among long term workers (greater than or equal to 21.5 years). There was also not a trend toward increased risk by level of cumulative exposure to asbestos among these workers. By contrast, employees with small opacities (greater than or equal to 1/0) experienced a significantly raised risk of lung cancer (nine observed deaths v 2.1 expected), even though their exposures to asbestos were similar to the exposures of long term workers without opacities. The authors concluded that excess risk of lung cancer was restricted to workers with chest radiographic evidence of asbestosis.

Other data suggests that the lung cancer risk is linearly related to dose and not to the presences or absence of asbestosis. For example, Wilkinson examined occupational and smoking data from 271 patients with a confirmed diagnosis of primary lung cancer and 678 controls from a hospital specializing in chest diseases [83]. To allow for adequate latency, workers were classified by the time they had spent in an occupation and assigned an exposure category (definite or probable) more than 15 years before diagnosis. Chest radiographs were interpreted by three readers and scored for small opacities. After adjustment for age, sex, smoking history, and area of referral, the odds ratio was 2.03 in

the subgroup of 211 with a median ILO score for small parenchymal opacities of 1/0 or more, and 1.56 (1.02-2.39) in the 738 with a score of 0/1 or less (i.e. those without radiological evidence of pulmonary fibrosis). The authors concluded that these data suggested that asbestos is associated with lung cancer even in the absence of radiographically apparent pulmonary fibrosis. Of course, limitations of the study include the accuracy of exposure estimates, the possibility of misinterpreting the chest radiographs when portions of the radiographs are blocked out (and one is unable to exclude other diseases that cause small opacities), and the absence of relationship between years of exposure and lung cancer risk particularly in those with normal (i.e. ILO 0/0) radiographs and sufficient latency. Further, the use of controls from a hospital population that is defined by the presence of chest disease is problematic.

Some studies have indicated that there is a dose-response relationship between asbestos exposure and lung cancer risk, even at low levels of exposure [84]. However, in his meta-analysis of asbestos-exposed lung cancer cohorts, Weiss found a high correlation between asbestosis rates and lung cancer rates in 38 cohorts, but a poor correlation between cumulative exposure data and lung cancer relative risks in the eight cohorts with adequate data [85]. One area of agreement, however, is that the latency period for lung cancer is generally shorter than that for mesothelioma and is likely greater than 15 years [86] but may be as long as 40 years [87].

Although no epidemiologic study is without flaws, the least confounded studies demonstrate that excess lung cancer risk was found only in those with radiographic or histologically demonstrated asbestosis [36, 82]. In the instance of the Hughes study, the prospective cohort design was more powerful in answering the causation question than

case-control or fiber burden studies. Further, in the studies that suggested that a synergy existed between asbestos exposure, cigarette smoking, and lung cancer risk, there was no distinction made between those with and without either radiographic or histologic asbestosis. If the cohort studies that identify the presence or absences of asbestosis are given the most weight in assessing lung cancer risk, the synergism would likely exist between *asbestosis* and cigarette smoking, rather than between asbestos exposure and cigarette smoking as first suggested by Selikoff. Therefore, while the weight of the scientific evidence favors asbestosis as a necessary precursor in order to diagnose an asbestos-attributable lung cancer [36, 85], not all have accepted this premise [83] and the issue will continue to be debated, particularly in matters of compensation.

III. Diagnosis of Asbestos-Related Lung Disease

A. Diagnosis of Asbestosis

Because histopathology is often not available in suspected cases of asbestosis, the diagnosis of this disease usually is based on clinical parameters alone. When pathologic material is available, a diagnosis of asbestosis is established when both asbestos bodies and fibrosis are present. Neither of these alone is sufficient in establishing a pathologic diagnosis. The diagnosis of asbestosis is usually based on clinical parameters and was described in an American Thoracic Society statement from 1986 [88].

In the Statement, the Committee recognized that pathologic material was rarely available in order to confirm a diagnosis of asbestosis but that the hallmark of asbestosis histopathologically was the demonstration of asbestos bodies in the presence of interstitial fibrosis. The authors of the Statement also commented that asbestos bodies

can be found in the lung tissue of non-exposed urban dwellers but were unassociated with surrounding lung parenchymal fibrosis.

Because of the infrequency with which lung tissue was available for microscopic analysis, clinical parameters were given higher importance in establishing a diagnosis of asbestosis. The clinical findings that were considered helpful in diagnosing asbestosis included:

1.) A reliable exposure history

2.) An appropriate time interval between exposure and detection of disease (a latency period of a "minimum of 15 years and more often considerably longer")

The Committee also reported several clinical criteria that were thought to be of *recognized value* (emphasis added)::

1.) Chest radiograph evidence of small irregular opacities with a profusion of 1/1 or greater

2.) A restrictive pattern demonstrated by pulmonary function testing (PFT)

3.) A diffusion capacity below normal

4.) Bilateral late inspiratory crackles

The consensus view expressed in 1986 was revised by a new group who convened in 2001 and published its Statement in 2004 [19]. Similar diagnostic testing was included in the updated criteria, but there was some modification in the manner in which the various clinical parameters were presented. As a result of the modifications in the Guidelines, the diagnostic criteria are more inclusive and non-specific and, therefore, not

especially helpful to the clinician. One example of the more inclusive nature of these criteria include the diagnosis of asbestosis with a 1/0 chest radiograph. Of course, as with any diagnostic guidelines, not all the criteria need be present to establish a diagnosis. Clearly, the presence of certain combinations of the criteria lends more certainty to a diagnosis of asbestosis. I will next present more information regarding the proper diagnosis of asbestosis.

1. Taking An Occupational History

As in most aspects of medicine, appropriate history taking is necessary in order to establish a proper diagnosis. However, in no area of medicine is this more important than in diagnosing occupational-related disorders. The ATS clearly articulates the need to take an appropriate exposure history. ATS at p. 695 ("The diagnosis of asbestosis is ideally based on an accurate exposure history, obtained whenever possible directly from the patient, that defines the duration, intensity, time of onset, and setting of exposure experienced by the patient...the occupational title is not enough, as the names of many occupations and trades are uninformative."). In addition to documenting the chronology of a worker's various jobs, one must ascertain at least a qualitative level of workplace exposures. This can, of course, be difficult when a worker has had many occupations spanning a long period of time. Further, recollections can vary regarding precise duration and types of exposure, or workers may be unaware that a potential asbestos exposure even existed in their own workplace. Alternatively, because the potential hazard of asbestos exposure has been brought to the attention of the public through the lay press and through the litigation proliferation, some workers may be overly concerned about their own asbestos exposure, even if only trivial. Therefore, for a variety of reasons,

workers may either underestimate or overestimate their asbestos exposure, which can diminish the quality of the information obtained during occupational history-taking.

In forming a work history chronology, the essential elements of the occupational history include the type of work performed, the duration of each job performed, and the type of asbestos-containing products that were used. Because of the latency of the asbestos related lung diseases, occupations performed greater than 15 years ago should be emphasized. Also, a description of the intensity of each exposure is necessary to, at least qualitatively, determine an estimated level of exposure. Patients should also be asked about their personal hobbies, living situation, and other non-occupational activities that could be associated with exposure to asbestos. Because workers can transport asbestos fibers via their work clothes, specific questions should be asked regarding relatives who worked in occupations that may have involved asbestos exposure. Of course, as with any medical history, intensity and duration of cigarette use must be defined as cigarette smoking is associated with the development of many lung diseases unrelated to pneumoconioses.

2. Exposure: What is Sufficient?

The exposure of workers to asbestos has diminished over the last decades due to a reduction in the permissible exposure limit (PEL). Beginning in 1972, exposure limits were imposed by the Occupational Safety and Health Administration (OSHA) to limit the amount of exposure present in the workplace. These limits were reduced from a level of 5 fibers per cc in 1972 to the current level of 0.1 fibers per cc. The tightening of the PEL has resulted in a decrease in the incidence of asbestosis and lung cancer. According to a

review of the available literature [81, 89, 90], the risk of developing either asbestosis or lung cancer does not exist until a cumulative dose of 25 to 100 fiber/cc-years is reached.

3. Physical Signs and Symptoms

A complete physical examination is an essential part of evaluating patients with suspected pneumoconioses. While physical examination findings are rarely specific for a particular occupationally-related lung disease, certain findings such as peripheral cyanosis, finger clubbing, or chest examination abnormalities may at least indicate that some sort of lung disease may be present. For example, while finger clubbing can be associated with asbestosis, it is also present in other lung diseases, especially idiopathic pulmonary fibrosis, cystic fibrosis, or bronchogenic carcinoma. Less common causes of finger clubbing include bronchiectasis, cirrhosis, tuberculosis, and lung abscess. Unfortunately, clubbing is rare even in established cases of asbestosis and therefore relying on its presence or absence is not helpful. However, when present, it is associated with a poor prognosis [91].

The symptoms usually are of an insidious onset and usually first include dyspnea. Chest pain occurs occasionally in advanced cases when a significant restrictive defect or extensive pleural thickening is present. The presence of persistent chest pain should prompt an investigation looking for the presence of an asbestos related pleural effusion, lung cancer metastatic to the chest wall, or a mesothelioma. Non-productive cough is common, particularly as the disease advances, but a productive cough can be present in cigarette smokers with chronic bronchitis. Hemoptysis is not a feature of the disease. If hemoptysis is present, one must exclude a concomitant bronchogenic carcinoma or other lung diseases commonly associated with hemoptysis (e.g. tuberculosis, pneumonia, or

pulmonary embolus). As with many lung diseases, advanced disease usually results in weight loss, likely due to the significant caloric expenditure associated with tachypnea.

The most consistent physical finding in patients with asbestosis is inspiratory crackles. Crackles (or rales) heard on chest auscultation is usually present in asbestosis but can also be found in patients with any interstitial lung disease, heart failure, bronchiectasis, or pneumonia. Also, there is some evidence that crackles can be heard in cigarette smokers in the absence of obvious pulmonary disorders. Determining at what part of the respiratory cycle that crackles are present has been suggested to be helpful in distinguishing among the lung diseases associated with this physical finding, but there is considerable overlap in this regard. Therefore, assigning importance to the timing of the crackles in the inspiratory cycle is problematic. Crackles associated with asbestosis are fine and usually occur with each inspiratory effort, a feature that unfortunately does not distinguish them from crackles due to any diffuse pulmonary fibrotic lung disease. At earlier stages of the disease, crackles are best appreciated in the lower lung zones, but, as the disease progresses can be found in all lung zones.

Wheezes are not a feature of asbestosis and, if present, lead one to consider airways diseases such as chronic bronchitis in cigarette smokers or asthma. A pleural rub can be heard in patients with diffuse pleural thickening. Cyanosis can be present in essentially any cardiopulmonary disorder that causes hypoxemia and therefore is not helpful in distinguishing between asbestosis and several other cardiopulmonary disorders. In advanced disease, signs of right sided heart failure (i.e. jugular venous distension, ascites, and lower extremity edema) can be found. Perhaps the most important aspect of the physical examination of exposed workers is the finding of physical signs that may

strongly suggest that another pulmonary disease is present (e.g. decreased breath sounds on auscultation and hyperresonance on percussion consistent with emphysema).

4. Radiographic Appearance

Chest radiographs are essential in the diagnosis of asbestosis. The chest radiograph can objectively determine, one, if there is a lung abnormality and, two, what that abnormality most likely represents. In this regard, the International Labour Office (ILO) has devised a classification scheme that attempts to rate the degree and type of radiograph abnormalities using a standardized system. The purpose of the ILO system was to standardize the interpretation of chest radiographs using descriptions of the size, shape, and degree of involvement (i.e. the profusion) of radiographic abnormalities. The system is used to organize the interpretation of the reader into shape (small regular or small irregular) and size assessments (small regular: p, q, r and small irregular: s, t, u). Further, the extent of radiographic abnormalities (profusion) is numbered from normal (or 0) to increasingly abnormal (1, 2, and 3). The ILO classification form also has a section where the reader indicates which of the six lung zones are involved (upper, middle, and lower in either the right or left lung). Also, particularly important when asbestos related lung disease, the presence and type of pleural abnormalities should be noted on the ILO form.

With regard to the typical chest radiographic appearance, certain distinct abnormalities exist with asbestosis. Asbestosis is generally characterized by ***lower lobe*** involvement with the presence of small ***irregular*** opacities (s, t, or u lesions). In advanced disease, these parenchymal abnormalities can be seen in all lung zones, but the abnormalities seen in lower profusion categories are typically lower zone predominant.

The radiographic changes associated with asbestosis are similar to other diseases where the predominant radiographic appearance is diffuse interstitial reticular infiltrates and cannot therefore be distinguished from these other entities by radiographic appearance alone. There is even some evidence that cigarette smoking alone can lead to radiographic changes that are similar to those due to asbestosis [92] (i.e. the presence of small irregular opacities). As the disease progresses, the linear opacities become thicker and may ultimately obliterate the vascular markings and honeycombing can be found, especially in the subpleural areas of the lower lobes. Large opacities are not seen in asbestosis, unless silica exposure also occurred and, if present, should raise the possibility of a lung malignancy.

Computed tomography (CT) scanning has increased the diagnostic sensitivity in diagnosing cases of asbestosis [93]. Particularly when using high-resolution CT (HRCT) scanning, parenchymal and pleural abnormalities not detected by plain radiography can be seen. CT scanning can also help distinguish en face pleural plaques seen on posterioranterior chest radiograph from parenchymal lesions and can be helpful in identifying parenchymal abnormalities when pleural changes obscure the lung parenchymal on plain chest radiographs. Unfortunately, CT scanning does little to help distinguish asbestosis from other fibrotic lung diseases such as idiopathic pulmonary fibrosis, collagen-vascular associated interstitial lung disease, and drug-induced lung diseases, just to name a few. Therefore, those studies that support the higher sensitivity of HRCT in diagnosing asbestosis [94-96] are limited by low specificity regarding the diagnosis of asbestos related parenchymal disease. Therefore, when using HRCT, the

challenge to the clinician is whether or not to assign clinical significance to marginally abnormal CT scans and to distinguish between true abnormalities and normal variants.

5. Pathophysiology

The physiologic abnormalities associated with asbestosis are due to the parenchymal fibrosis that characterizes the disease. Classically, when advanced asbestosis is present, reduced lung compliance resulting in a restrictive lung defect is the most common pulmonary function abnormality. Specifically, a reduction in the residual volume (RV) and the total lung capacity (TLC) is usually seen. However, because some patients with asbestosis also have cigarette-inducted emphysema (characterized by increased RV and TLC), a normal or even increased RV and TLC can be present, depending on the relative contribution of each disease to the patient's pathophysiology. This situation results in a mixed obstructive-restrictive defect. Also, because of replacement by scarring of the gas exchange surface at the alveolar level, a reduction of the diffusing capacity is often seen, and some have identified a reduced DLCO as an early indicator of disease. Further, because of the presence of low lung compliance, increased minute ventilation is observed as the respiratory rate increases and the tidal volume decreases. The ventilation changes are particularly marked at the lung bases, which is the area of the lung most extensively involved in asbestosis. All the respiratory mechanics abnormalities are exacerbated by exercise and exercise testing is one way, although invasive and non-specific, to unmask occult disease. Unfortunately, the pathophysiologic findings described above for asbestosis are non-specific and can be found in any of the restrictive lung diseases.

Although asbestosis has traditionally been considered to cause a restrictive impairment, there is some medical literature which documents airway obstruction in asbestos-exposed workers who have normal radiographs with no clinical evidence of asbestosis [97, 98]. The mechanism by which asbestos may cause airway obstruction is unclear but may involve the deposition of asbestos in the small airway, leading directly to an inflammatory response that causes airway fibrosis [99-101]. Whatever the mechanism, the confounding effects of the high prevalence of cigarette smoking in this population has been a limitation of many of the studies performed to evaluate this issue and may undermine the ultimate conclusions. Further, the clinical importance of these histologic effects is unknown.

Very few studies have used radiographic, lung function, and exposure data sufficient to make dose-response conclusions. One such study by Weill and colleagues [102] published in 1975 evaluated the radiographic, lung function tests, and dust exposure data on 859 workers in two asbestos cement plants. The effects of age, race, smoking history, and presence of radiographic abnormalities were controlled. The investigators were able to demonstrate clear dose-response relationships between increasing exposures and declining FEF_{25-75}. However, the authors were not able to show a decrease in the FEV_1/FVC ratio, suggesting that while small airway physiologic abnormalities may have be present, clinically significant obstructive disease (as generally defined by a reduced FEV_1/FVC ratio) was not present.

A study of 2,611 long-term asbestos insulators examined the prevalence of spirometric impairments in a large exposed population and the effects of cigarette smoking, radiographic abnormalities, and duration from onset of exposure on pulmonary

function [98]. Only 3 percent of nonsmokers had obstruction, and 6 percent had a decreased FEV_1/FVC ratio. Obstruction (present in 17 percent) and combined impairment (in 18 percent) were most common in current smokers. The FEV_1/FVC was decreased in 35 percent of current smokers and in 18 percent of ex-smokers. Normal spirometry was most common when the radiograph was normal; almost half the workers with normal radiographs had normal spirometry. Nevertheless, FVC was reduced in 27 percent of those with normal radiographs and a normal radiograph was seen in 11 percent of workers with restriction. Restrictive and combined impairments were most frequent when both parenchyma and pleura were abnormal. The authors concluded that reduced FVC and reduced FEV_1/FVC are both more frequent in insulators who have smoked (compared with non-smoking insulators or smokers in the general population), which in the authors viewpoint suggested an interaction between asbestos and smoking in producing both these physiologic abnormalities. However, airways obstruction in the absence of radiographic abnormalities and/or cigarette smoking was uncommon.

Other studies that have examined non-smoking asbestos exposed cohorts have had methodological limitations. For instance, in studies where radiographic information is unavailable, the role of asbestos alone in causing airflow obstruction in workers without radiographic disease cannot be determined. Further, other studies have been unable to find differences in the prevalence of obstruction in smoking and non-smoking groups [103, 104]. Studies of nonsmoking asbestos exposed workers where radiographs were available found small airway obstruction as evidenced by a reduction in midflow testing (an effort dependent test), but no decrements in FEV_1 and FVC were documented. A study by Kilburn which included radiographic examined 97 nonsmoking insulators who

had significantly reduced FEV_1 when compared to a population of nonsmokers. There were parenchymal opacities with a profusion of 1/0 or greater in 7 and pleural changes in 13 of these 97 nonsmokers. The authors concluded that, in the absence of cigarette smoking and other diseases, there is decreased airflow in an asbestos exposed population, although the decline was quite small [105]. A more recent study by Kilburn [106] concluded that asbestos exposure alone causes airway obstruction, but there was no difference in lung function between those exposed workers who did and those who did not have asbestosis, making the radiographic interpretations questionable. Further, among the nonsmokers, mean FEF_{25-75} values were above 80%, lending doubt to the conclusion that significant airway obstruction occurred from asbestos exposure alone. These and other limitations of the Kilburn study are well outlined in an article by Jones [107].

The studies evaluating the effect of asbestos on airway function are inconclusive. If there is a direct asbestos effect, it likely only involves the small airways, is small, and clinically insignificant, particularly when compared to the effect of cigarette smoke on airway function [108, 109]. Even though airway fibrosis following asbestos inhalation has been demonstrated in animal models, the clinical impact in humans of these histologic changes remains uncertain. There may be a difference between the histologic and physiologic finding of small airways disease (from smoking or dust) and progressive, clinically significant COPD. The link between the former and latter appears not to have been established. If asbestos exposed workers do have significant respiratory disability, the impairment is likely due to a restrictive, rather than an obstructive, process.

6. Distinguishing Among the Diffuse Interstitial Lung Diseases

Given the number of diseases that resemble asbestosis radiographically, the ATS Statement clearly states that a diagnosing doctor must exclude other possible etiologies of the abnormality observed on chest x-ray. 2004 ATS Statement at p. 702 ("Asbestosis resembles a variety of other diffuse interstitial inflammatory and fibrotic process in the lung and must be distinguished from other pneumoconioses, IPF, hypersensitivity pneumonitis, sarcoidosis, and other diseases of this class."). As described above, asbestosis presents radiographically with reticular (or linear) abnormalities, but many fibrotic lung conditions have a similar radiographic appearance. In addition to a reticular pattern, many fibrotic lung diseases are characterized radiographically by lower zone predominance, traction bronchiectasis, and honeycombing.

Distinguishing among these diseases requires the clinician to consider other non-radiographic factors, most notably a careful work history and, if available, pathologic tissue. Particularly in instances where other causes of diffuse interstitial lung disease need to be excluded, a lung biopsy (preferably by obtaining adequate tissue through a surgical approach) should be considered. Also, the clinical course can give some hint about the etiology of the diffuse lung infiltrates. For instance, one is more confident that the patient does not have asbestosis if there is rapid clinical progression, which instead would favor a diagnosis such as IPF. Diagnostic uncertainty can be particularly pronounced when concomitant emphysema or other lung conditions are present, which alter the typical radiographic and pathophysiologic picture. Suffice it to say, the diagnostic possibilities are numerous when confronted with patients who have diffuse lung parenchymal abnormalities.

B. Asbestos-related Pleural Changes

As discussed above, there are numerous other diseases that can cause pleural changes, and there are other physical changes that mimic asbestos-related pleural changes on an x-ray. Accordingly, it is crucial to exclude other potential causes of observed pleural changes prior to diagnosing somebody as having an asbestos-related pleural change. Other causes of pleural plaques include pleural thickening due to trauma, previous infection, or radiation therapy to the chest. Most importantly, pleura or extra-pleural fat can be misdiagnosed as a pleural plaque or diffuse pleural thickening.

C. Mesothelioma

Diagnosis of Mesothelioma

Mesothelioma should be considered in patients who have an adequate exposure history and latency period and in who characteristic chest radiographic findings are present (see below). In patients who present with such findings, the next diagnostic step should be a thoracentesis, which is helpful in excluding other causes of unilateral pleural effusions but is rarely diagnostic for mesothelioma. High levels of hyaluronic acid may be found in the pleural fluid, but its presence is inconsistent [110]. When a high concentration of hyaluronic acid is present, there is some evidence that it is associated with a better prognosis [111, 112]. Also, a high serum hyaluronic acid level can help differentiate pleural effusions due to mesothelioma and those due to other causes and may be helpful following an individual patient's clinical course [112]. Other biochemical markers, such as the carcinoembryonic antigen, have been reported to be helpful, particularly when distinguishing mesothelioma from adenocarcinoma. In tissue analysis, when used in combination with a negative mucin stains for adenocarcinoma, a negative

CEA adds further support to a diagnosis of mesothelioma [113]. In a study investigating the role of CEA measurements in pleural fluid, no cases of cytologically confirmed cases of mesothelioma had a CEA level greater than 2.9 ng/ml while 67% of the adenocarcinomas tested were above 15 ng/ml [114]. More recently, the CEA in combination with another tumor marker CYFRA 21-1 were found to be helpful in distinguishing between mesothelioma and metastatic pleural cancers. An elevated CYFRA 21-1 level with a low CEA level was found to be highly suggestive of mesothelioma, while a high CEA level alone or high levels of both markers suggested a diagnosis of other causes of malignant effusions [115].

Pleural biopsy, ideally via video-assisted thoracoscopic surgery (VATS), is the diagnostic gold standard for mesothelioma. Using VATS, tumor studding of the pleural surface can be appreciated, and the surgeon is able to perform biopsies under direct visualization. Another benefit of this procedure is the ability to mobilize the lung and to perform cytoreductive pleurectomy [116].

D. Lung Cancer

The diagnosis of lung cancer in workers exposed to asbestos is done in the same way as people who are unexposed. It is beyond the scope of this report to describe the diagnostic approach used in suspected lung cancer cases but ultimately the lung cancer diagnosis relies on lung tissue confirmation and is generally obtained through biopsy of the lung directly.

IV. Diagnosis of Asbestos Related Lung Disease in the Medical – Legal Setting

A. Incidence of Asbestos – Related Lung Disease: Can A True Incidence Be Known?

For the last decade or more, the prevalence of asbestos-related disease has been a matter of considerable debate. A major confounding factor in establishing the true prevalence of these diseases is the propagation of legal cases which are established only if a diagnosis of an asbestos related condition is made. This has resulted in the reporting of the disease (e.g. on death certificates) when it truly did not exist. This practice, therefore, has led to an unclear picture of true, new cases of asbestos-related lung disease, as opposed to those individuals who are "diagnosed" without strict adherence to diagnostic criteria. Fortunately, with the institution of policies which limit occupational exposure to asbestos, the incidence of asbestos related lung conditions is decreasing. Despite polarized viewpoints regarding the true prevalence of these diseases, most would agree that the severity of the diseases, if present, is much less.

While there is not clear data regarding the prevalence of nonmalignant asbestos related diseases, there is data to support a declining number of new mesothelioma cases. In an analysis of the Surveillance, Epidemiology, and End Results (SEER) data, Weill examined mesothelioma trends from 1973 to 2000 [47]. The analysis focused on mesothelioma rates for men given the strong association with occupational asbestos exposure in men. Given that mesothelioma is strongly related to amphibole asbestos exposure and that amphibole use in the United States peaked in the 1970s, one would expect a peak in disease incidence after an appropriate latency period of greater than 30 years. The SEER data did suggest that peak mesothelioma incidence for men occurred in the early to mid 1990s and has subsequently declined. Mesothelioma rates for women

have been fairly constant and likely represent background rates for the disease. Similar conclusions were reached in a study by Price [117].

In the following section, I will focus my comments on the diagnosis of *non-malignant* asbestos related lung disease in the legal setting, largely because there is usually very little dispute among parties about the validity of the diagnosis of *malignant* conditions. Instead, in malignant cases, the issue of causation is the primary one, rather than whether the plaintiff actually has cancer. Further, with regard to the number of claims outstanding in state and federal courts, the non-malignant claims far outweigh the malignant claims, perhaps by a ratio of 10 to 1.

B. Screening (litigation vs. standard practices)

As described in Judge Jack's opinion in the Federal Silica MDL, the screening process seen in the silica litigation generated claims that were not based on scientifically and medically valid diagnoses. The same doctors described in the Judge Jack opinion have also made countless inaccurate diagnoses in the asbestos arena. Mass screening of workers allegedly exposed to occupational dusts has increased over the last decade and has been the primary diagnostic mechanism by which non-malignant asbestos claims are generated. These mass screenings are the product of an industry that has included companies devoted entirely to the performance of chest radiographs and pulmonary function testing and who hire physicians to perform cursory physical examinations and history taking and/or chest radiograph interpretation. The results of this screening process are then sent to plaintiff firms who then decide whether to carry the claim forward.

An important element of the screening process are physicians who see an inordinately large number of patients, usually in non-clinical settings (e.g. union halls and

hotels), and who follow a diagnostic procedure that differs markedly from the one used in standard medical practice. Before discussing how the screening diagnostic strategy differs from that used in standard medical practices, it is instructive to understand how the mass screening process works. Through my work in the In re Silica MDL as well as my work in individual cases that were generated from the screening process, I have developed familiarity with the process. The screening process differs from screening company to screening company, but most use similar methods to generate claimants. First, the plaintiff law firm provides the screening company with a list of potentially exposed workers, perhaps obtained through union records or by other means. Second, a mass mailing is sent by the screening company to those on the list notifying the time and the place of a mass screening in the worker's area. The worker is encouraged to attend the screening if exposed, without regard to how much or in what setting or interpreted by someone with a medical background. Third, a chest radiograph is taken at the screening and sent to a B reader (reference) hired by the plaintiff law firm. Fourth, if the chest radiograph is interpreted as being "positive" for a occupational related lung disease, the worker is instructed to attend another screening where a history and physical examination is conducted by one of the diagnosing physicians, who almost entirely rely on the exposure history obtained by the non-medical personnel who greets the worker at the screening. Finally, based on a very brief visit with the worker (on the order of 3 to 5 minutes per patient and perhaps 60 to 100 workers per day), the physician generates a report describing the presence of a dust-related lung disease and what the likely cause is. This report is then sent to the plaintiff law firm who files a claim on behalf of the worker.

I will now discuss how exactly the screening diagnostic procedure differs from the diagnostic process used in the typical practice of medicine. First, the diagnosing physicians in the litigation setting are not the worker's treating physicians and, in fact, often do not practice in the same city or state in which they are seeing the worker. Second, the diagnosing physicians are often relying entirely on an exposure history (a key part of the diagnosis of asbestos related lung disease) that was obtained by non-medically trained personnel. Further, this relatively small group of diagnosing physicians has been affiliated with a few screening companies and a handful of plaintiff law firms. Also, as opposed to what a physician should do in their usual medical practice, the diseases that are diagnosed by this group of physicians are generally not reported to state or federal agencies that track the prevalence of many work-related diseases for purposes of disease surveillance. For the reasons outlined above, one sees a "decoupling" between what the diagnosing physicians are doing in the litigation setting and what is commonly accepted as good diagnostic practices in the usual clinical setting.

C. Criticisms of Diagnosing Strategies in Litigation

After having discussed generally how the screening process works and some of its flaws, I will now turn to the component parts of the screening diagnosis and reveal their failings in the litigation-screening process.

1. Occupational History

As noted previously, the occupational history is an essential part of diagnosing occupational lung diseases. The proper way to obtain an occupational exposure history is detailed in the section regarding the diagnosis of asbestosis. An appropriate occupational

history requires diligent fact-finding, characterized by detailed questioning by a healthcare professional who is well-versed in the wide variety of occupational settings. This process, by its nature, is time-consuming but necessary in order to construct an exposure history which will best estimate a patient's risk of developing an asbestos-related disease.

Unfortunately, a very different process has occurred in the diagnostic settings that have been established purely in support of lawsuits. In these settings (often mobile testing services) untrained, or at best minimally trained, personnel take a cursory history or simple give the worker a questionnaire to complete which usually has no more than the name of the company, the year(s) employed, and the job title. This information is clearly inadequate in order to establish a diagnosis. In some mass screenings, a physician has personally performed the occupational history. However, based on the number of patients often seen in a single day (sometimes 40 to 100 or more), a careful occupational history could not have been taken, regardless of the questioner. Therefore, even before the worker has entered the diagnostic testing phase (i.e. chest radiographs and pulmonary function tests) of the evaluation, an integral component of the diagnosis, namely the occupational history, has been inadequately performed.

2. Radiograph Interpretation

The interpretation of chest radiographs in suspected pneumoconiosis cases is performed using the International Labour Organization (ILO) classification system. This system was described in detail earlier in the section on the diagnosis of asbestosis. While originally designed for surveillance and epidemiological purposes, the system has been,

and continues to be, used extensively in the litigation setting. Unfortunately, while contrary to accepted diagnostic methods, the "positive" chest radiograph has become synonymous with a diagnosis of non-malignant asbestos-related lung disease, even though there are other necessary component parts in establishing a proper diagnosis. Even more concerning is the apparent effort on the part of some B readers to read nearly all films referred to them in a litigation context as "positive" [118], which would defy expectations (and logic) in a chest –ray sampling of a representative worker population. The systematic interpretation of an inordinately large number of chest x-rays as "positive" was discussed extensively in Order 29 issued by Judge Janis Jack in the Federal Silica Multi-District Litigation (MDL) in the United States District Court for the Southern District of Texas in the Corpus Christi Division.

3. Consideration of Alternative Causes

The routine failure of doctors for screening companies to rule out other potential causes of disease or observed radiographic changes makes their diagnoses unreliable. There are many diseases that radiographically mimic asbestosis. Some of these diseases have no known cause, while others have a readily identifiable cause. All are characterized by bilateral, interstitial infiltrates located diffusely throughout the lung zones. While some have easily identifiable characteristics which point one toward a certain diagnosis, most of the interstitial diseases have no specific differentiating characteristics. In the absence of distinguishing radiographic features, the clinician must then rely on other factors to exclude certain diagnoses, including exposure history (occupational, non-occupational, and medication), family history, and previous medical

history. Particularly in the case of previous medical history, the examiner must perform a thorough medical history (and, if necessary, a review of medical records) in order to exclude existing medical conditions that may explain radiographic abnormalities that might be present. This is especially important in the setting of mass screenings that, due to the large number of people screened, are more likely to encounter a pulmonary disease which may closely resemble an occupationally related lung disease, like asbestosis.

4. Mixed Dust Pneumoconiosis

In the litigation screening setting, a significant number of workers have been given a diagnosis of "mixed dust pneumoconiosis". This practice was identified by Judge Jack in the Federal Silica MDL. Although inaccurately labeled, plaintiff-hired examining physicians are using the term "mixed dust pneumoconiosis" to describe a condition where both asbestosis and silicosis are present in the same worker. Although extremely rare, it is theoretically possible for one person to have both diseases. A person could be exposed to both silica and asbestos in sufficient quantities to cause either disease. But it would be extremely unusual for one person in a working lifetime to have sufficient exposure to both types of dust to cause both diseases. In my clinical experience in the United States, I have never seen a case like this. I've also spoken to colleagues who saw patients years ago when exposure levels were much higher, and they have had difficulty recalling an individual worker who had both asbestosis and silicosis. Even in China, where I saw workers with jobs involving high exposure to asbestos and silica, I did not see anyone or review chest radiographs of anyone who had both silicosis and asbestosis. It is my

opinion that workers are given a diagnosis of asbestosis and silicosis (called "mixed dust pneumoconiosis" in the litigation setting) as simply an attempt by plaintiff attorneys to use an individual client in order to collect two separate awards. A recent consensus report [119] reviews the true meaning of mixed dust pneumoconiosis, which in medical terms implies that a patient has pathologically a dust macules or mixed dust fibrotic nodules with or without associated silicotics nodules. The exposure in these cases was usually to a mixture of crystalline silica and nonfibrous silicates.

V. Pulmonary Function Testing and Impairment

Although pulmonary function testing (PFT) has traditionally been an important part of the diagnostic evaluation of workers with suspected pneumoconiosis, the validity of PFT obtained in the medical-legal setting has been rightly questioned. Similarly, because state statutes, such as the ones in Texas, Ohio, Georgia, and Florida, require a demonstration of impairment in order to proceed with a claim, the methods by which impairment is assessed has been debated as well. The discussion regarding the validity of PFT testing cannot be separated from the impairment issue, as the basis for determining the latter is significantly based on the reliability and reproducibility of the former. Therefore, the demonstration of impairment is a two-step process: one, obtaining PFT that are reliable and meet ATS criteria and, two, determining that the PFT abnormalities, if present, meet well-defined impairment standards. The issue regarding PFT and impairment classification will now be discussed.

A. BACKGROUND ON PULMONARY FUNCTION TESTS

The proper performance and interpretation of pulmonary function tests can be found in various ATS publications (e.g. Official Statement of the American Thoracic Society, "Lung Function Testing: Selection of Reference Values and Interpretative Strategies," 144 American Review of Respiratory Disease 1202-1218 (1991); Official Statement of the American Thoracic Society, "Standardization of Spirometry: 1994 Update," Am J Resp Crit Care Med 152: 1107-1136 (1995); Official Statement of the American Thoracic Society, "Single-breath Carbon Monoxide Diffusing Capacity (transfer factor): Recommendations for a Standard Technique - 1995 Update," Am J Respir Crit Care Med 152:285-298 (1995). The factors influencing the proper performance of PFTs is highly technical, and a discussion describing all of the ATS criteria is beyond the scope of this report. However, it is critically important that these tests be performed and interpreted correctly if one is to rely upon their results for impairment determinations. If the tests are not valid and reproducible, there exists the potential to assign impairment to someone who would not be considered impaired if the tests were performed properly.

Spirometry

Spirometry is the most commonly administered component of the pulmonary function testing. Spirometry measures air flow, which is expressed as volume exhaled per unit of time. In doing so, spirometry is able to distinguish among people who have no impairment and those who have either a restrictive or an obstructive lung disease. The most important spirometric measurements are the forced vital capacity (FVC), forced expiratory volume in the fist second (FEV-1), and the FEV-1/FVC ratio. Forced vital

capacity is the total volume of air that is expired on a maximal exhalation effort by the patient. FEV-1 is the volume of air expired in the first second of the FVC maneuver. In patients with obstructive lung disease, such as emphysema, the FEV-1/FVC ratio is reduced. Conversely, in those patients with restrictive disorders, such as asbestosis, the FEV-1/FVC ratio is increased. While other lung diseases can cause either an obstructive or restrictive impairment, spirometry allows one to put diseases into one of these two broad categories.

The ATS has promulgated certain criteria for administering and interpreting spirometry tests, such as:

1. **There should be an obvious end of exhalation, demonstrated by a plateau for at least one second after an exhalation time of at least 6 seconds.**

2. **Because this determination requires the PFT interpreter to examine the actual efforts made by the worker in graphic form, the ATS requires that the spirometry graphs be of sufficient size in order that someone interpreting the exam can discern whether there is testing artifact, such as coughing, sneezing, or delay in exhalation.**

3. **In order to be sure that the tests are reproducible, the largest and second largest FEV-1 and FVC must be within 0.15 liters of each other.**

These spirometry criteria, upon which impairment criteria are based, are often not met in the litigation setting and therefore do not allow confidence about their interpretation.

Diffusing Capacity

In addition to spirometry standards, the ATS also has criteria for the determination of the diffusing capacity. The diffusing capacity test (DLCO) is performed separately from spirometry and is a measurement of gas exchange capability of the lung. Specifically, DLCO measures the ability of the gas exchange membrane to diffuse carbon monoxide. This test will provide information about the ability of the lung to absorb oxygen. In diseases that impair oxygenation, such as emphysema and a variety of interstitial lung diseases, the DLCO will be reduced. As is the case with the spirometry values, failure to perform the DLCO test properly leads to unreliable test results that cannot be relied upon when making impairment judgments. Even if a claimant's DLCO is less than the lower limit of normal, however, his pulmonary function test still cannot be used to demonstrate Class 2 or higher impairment if it fails to comply with the following requirements set forth in the ATS DLCO, AMA 5th Edition.

The following describes the technical factors involved with the performance of the DLCO that may reduce the reliability of the DLCO measurement:

1. **Inspired Volume is not 90% of the largest previously measured vital capacity.**

The ATS DLCO requires that an individual's inspired volume be at least 90% of the largest previously measured vital capacity. This criterion relates to the degree to which the patient adequately performed the test.

2. **Washout volume is inside the dead space.**

The ATS DLCO requires that the washout volume be outside the dead space: "If a continuous gas analyzer system is used, computerized or manual inspection of the expired CO and tracer gas curves may be used to adjust washout volume to assure dead space clearance." ATS DLCO at 2190. An individual plaintiff's pulmonary function test

would fail this requirement if the washout volume is inside the dead space on all trials of the DLCO test.

3. **There are not two acceptable DLCO trials.**

The ATS DLCO requires two acceptable DLCO trials. An individual would not meet this criterion if there are no acceptable trials during which the inspired volume is not at least 90% of the largest previously measured vital capacity and the washout volume is inside the dead space.

4. **Exercise testing should be performed in certain circumstances.**

The AMA 5th Edition requires that an individual have exercise testing if FVC, FEV1 and FEV1/FVC are normal and DLCO is between 41% and 79% "to determine level of impairment." AMA, 5th Edition, at 107, Table 5-12. If an individual plaintiff contends that his DLCO is less than the lower limit of normal, then exercise testing is required, but often not provided.

B. IMPAIRMENT

Impairment is a clinical assessment based on all of the available medical information, including chest radiograph and pulmonary function testing. The American Medical Association (AMA), in its most recent fifth edition, puts forth guidelines that grade impairment. The AMA Guidelines for pulmonary impairment are shown in the table below:

INSERT TABLE FROM AMA GUIDELINES

In order to demonstrate the required Class 2 or higher impairment, a plaintiff's pulmonary function test must comply with criteria set forth in the following publications:

1. American Medical Association Guides to the Evaluation of Permanent Impairment, 5th Edition. (Hereinafter referred to as the "AMA, 5th Edition".)
2. Official Statement of the American Thoracic Society, "Lung Function Testing: Selection of Reference Values and Interpretative Strategies," 144 American Review of Respiratory Disease 1202-1218 (1991).
3. Official Statement of the American Thoracic Society, "Standardization of Spirometry: 1994 Update," Am J Resp Crit Care Med 152: 1107-1136 (1995). (Hereinafter referred to as the "ATS Spirometry".)
4. Official Statement of the American Thoracic Society, "Single-breath Carbon Monoxide Diffusing Capacity (transfer factor): Recommendations for a Standard Technique - 1995 Update," Am J Respir Crit Care Med 152:285-298 (1995) (Hereinafter referred to as the "ATS DLCO".)

Under the AMA 5th Edition, Class 2 or higher impairment is when the (1) the FVC is less than the lower limit of normal; (2) the FEV1 is less than the lower limit of normal; or (3) the DLCO is less than the lower limit of normal. AMA, 5th Edition, at 107. Although the AMA Guidelines are generally helpful in assessing individuals with suspected lung disease, they are not specific for the asbestos-related diseases and cannot be solely relied upon to make impairment assessments. Instead, as will be discussed in more detail below, the AMA Guidelines are best used in conjunction with PFT abnormalities typically seen in asbestos-related diseases, which lends more specificity to the impairment assessment without leading to the exclusion of individuals with true disease.

VI. Diagnostic Strategy for the Outstanding Grace Claims

Various legislative bodies have developed or are developing statutory regimes to address asbestos claims. The proposed FAIR Act, in its current form, would establish a litigation trust to address all outstanding asbestos claims, while various state legislatures have sought to address the asbestos litigation issue with bills based on the premise that specific medical criteria must be met in order to file a claim in court. While the bills

have differed somewhat in terms of their specific criteria, all have common criteria which must be met. These criteria categories include:

1.) Exposure history (and how it should be obtained)

2.) Three independent chest radiograph interpretation (and minimum thresholds for establishing disease)

3.) Pulmonary function tests (and under what circumstances the tests should be performed)

4.) Demonstration of impairment (using established American Medical Association Guidelines)

In order to properly decide who has an asbestos related disease, strict medical criteria should be applied. The important components should include the following:

A. Exposure History

As mentioned in Section III of this report, the proper taking of a careful exposure history is vital when diagnosing asbestos–related conditions. The person taking the history should be adequately trained in workplace exposures and be able to illicit detailed information about the specific nature of a person's exposure. The history should not simply contain job titles and the company name of where one worked but rather comprehensive information about the chronology of workplace exposures, frequency of exposures, type of respiratory protection used, and proximity to others using asbestos

products in the work environment. If this is not done, the occupational history is unhelpful and does not allow one to determine if an individual's exposure was sufficient to increase the risk for an asbestos-related disease. This process is time consuming but should not be relegated to personnel who are inadequately trained in obtaining exposure histories.

Therefore, all exposure histories should either be taken by the physician directly or through a surrogate who has received special training in work-related history taking. Failure to obtain a proper exposure history would likely result in information that is unhelpful at a minimum and, at worst, misleading.

B. Radiographic

In order to receive compensation for an asbestos-disease claim, a person must have an abnormal x-ray defined by (1) a profusion category greater than or equal to 1/0 and/or (2) diffuse pleural thickening (extent 2 or greater) in the absence of parenchymal lung disease.

The chest radiographs used for evaluation should comply with the International Labour Office's Guidelines for the Use of ILO International Classification of Radiograph of Pneumoconiosis. The ILO form itself is insufficient in determining the validity of the x-ray interpretation and merely captures another doctor's opinion. This opinion cannot be confirmed in the absence of viewing the actual radiograph itself. Therefore, all chest radiographs submitted for a claim should be read by a panel of at least three independent B readers in order to ensure the validity of the chest radiograph interpretations. Further, control films of normal subjects should be inserted into the radiograph sets in order to

assure quality control. By panel reading all the chest radiographs, one can be reasonably assured that the abnormal radiographs will be properly separated from the normal ones and the impact of any single reader's interpretation, particularly if outside the range of the readings of the other panel members, will be diminished. For precisely this reason, this practice is consistent with how radiographs are interpreted in large epidemiologic studies and in other countries for compensation purposes. Panel reads of chest radiographs should be a central component of any claims process.

Histologic evidence of disease may be used in place of a chest radiograph.

C. Pulmonary Function Testing

As described in detail in a previous section, pulmonary function tests need to be performed in compliance with ATS criteria in order to be deemed reliable. A failure to do so makes the tests of limited value. In evaluating claims made to the Grace Trust, the individuals must have pulmonary function tests that adhere to ATS criteria and are performed at pulmonary function laboratories that have quality assurance practices in place. Failure to do so should lead to the exclusion of consideration of the claim or require that re-testing in compliance with ATS criteria be performed.

D. Demonstration of Impairment

A claimant must also demonstrate that he has pulmonary impairment in order to recover against the trust. All assessments of impairment should comply with the quality control standards put forth by the AMA in its Guides to the Evaluation of Permanent Impairment and the ATS in its Official Statement. It should be made clear, however, that

although the impairment guidelines outlined above are routinely used to assess a variety of pulmonary diseases, there are no guidelines that are specific to asbestos-related diseases. As such, the guidelines should be considered attempts toward complete inclusion (i.e. high sensitivity) rather than specific for asbestos related diseases.

For asbestosis claims, the impairment criteria varied among the state statutes recently passed. Without discussing in detail the statutes in all 4 states, impairment criteria using the AMA Guides Class 2 or higher and/or PFT abnormalities specific to asbestosis was utilized. For example, in Ohio, claimants must demonstrate an abnormal x-ray and have pulmonary function tests demonstrating Class 2 impairment or higher plus an FVC less than the lower limits of normal, an FEV-1/FVC ratio equal or greater than the lower limits of normal, and a total lung capacity less than the lower limits of normal. In other states such as Georgia and Texas, the AMA Guidelines were not used but rather PFT abnormalities specific to asbestosis of the kind described above. In all of the state statutes, an effort was made to couple the AMA Guidelines with PFT abnormalities commonly seen in asbestosis, which seems rational and far preferable to simply trying to fit all respiratory diseases to the rather general AMA Guidelines.

Moreover, an effort should be made to determine whether the pulmonary function abnormalities demonstrated can be easily explained by other non-asbestos related chest diseases or previous chest surgeries.

E. Other Considerations

The application of medical criteria to the diagnosis of asbestos related disease has other considerations as well:

1) The diagnosing physician should have board certification in pulmonary or occupational medicine and have a patient-physician relationship with the person being evaluated.

2) The medical history should be obtained directly by the treating physician or by personnel specifically trained in this discipline under the direct supervision of the physician.

I will review the medical records attached to the various claimant questionnaires to determine the validity of the diagnoses. I will include my findings in a supplemental report.

VII. Libby, Montana

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VIII. CONCLUSIONS

Any trust developed to handle the asbestos-related claims made against W.R. Grace will need to be based on medical criteria that ensure that only valid claims are compensated. Only the truly injured should be compensated and the severity of disease, if present, should be determined using well-defined medical criteria. A Trust structured in this way would be fair, particularly to those workers who are truly injured.

With the exception of those individuals diagnosed by Drs. Whitehouse and Black, I have not based this report on a review of the individual claimants' medical records. I reserve the right to supplement my opinion based on a review of additional medical records made available to me. Additionally, I reserve the right to submit an estimation report as well.

David Weill

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